

# Deploying Serious Games for Management in Higher Education: lessons learned and good practices

Citation for published version (APA):

Baalsrud Hauge, J., Bellotti, F., Nadolski, R., Kickmeier-Rust, M., Berta, R., & Carvalho, M. B. (2013). *Deploying Serious Games for Management in Higher Education: lessons learned and good practices*.

## Document status and date:

Published: 06/11/2013

## Document Version:

Peer reviewed version

## Document license:

CC BY-NC-SA

## Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

## General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

<https://www.ou.nl/taverne-agreement>

## Take down policy

If you believe that this document breaches copyright please contact us at:

[pure-support@ou.nl](mailto:pure-support@ou.nl)

providing details and we will investigate your claim.

Downloaded from <https://research.ou.nl/> on date: 06 May. 2023

Open Universiteit  
[www.ou.nl](http://www.ou.nl)



# Deploying Serious Games for Management in Higher Education: lessons learned and good practices

Jannicke Baalsrud Hauge<sup>1</sup>, Francesco Bellotti<sup>2</sup>, Rob Nadolski<sup>3</sup>, Michael Kickmeier-Rust<sup>4</sup>, Riccardo Berta<sup>2</sup>, Maira B. Carvalho<sup>2</sup>

<sup>1</sup>Bremer Institut für Produktion und Logistik at the University of Bremen, Bremen, Germany

<sup>2</sup>Dept of Electronic and Telecommunication Engineering, University of Genoa, Genoa, Italy

<sup>3</sup>Centre for Learning Sciences and Technologies, Open University Netherlands, Netherlands

<sup>4</sup>Knowledge Management Institute, Graz University of Technology, Graz, Austria

[baa@biba.uni-bremen.de](mailto:baa@biba.uni-bremen.de)

[franz@elios.unige.it](mailto:franz@elios.unige.it);

[rob.nadolski@ou.nl](mailto:rob.nadolski@ou.nl);

[michael.kickmeier-rust@tugraz.at](mailto:michael.kickmeier-rust@tugraz.at)

[berta@elios.unige.it](mailto:berta@elios.unige.it)

[Maira.Carvalho@elios.unige.it](mailto:Maira.Carvalho@elios.unige.it)

## Abstract

The deployment rate of serious games (SGs) in higher education (HE) and their proper insertion in meaningful curricula is still quite low. There is a lack of papers in literature describing deployment of SGs for HE in detail, critically showing educational benefits, and providing guidelines and best practices on their use. With the present work, we intend to make a first step in this direction, by reporting our experience in using state of the art managerial SGs in MSc Engineering/business courses in four different European universities. In order to describe and analyse the educational characteristics and effectiveness of each game, we propose to use two models that we have straightforwardly extracted from two major pedagogical paradigms: the Bloom's revised cognitive learning goals taxonomy and the Kolb's experiential learning cycle. Based on our experience in developing the SG-based courses, we also propose a set of lessons and practices that we believe could be of interest to incentivize and better support deployment of SGs in HE courses.

## 1. Introduction

While there is a certain consensus about the educational potential of Serious Games (SGs) (Bellotti et al., 2010; Greitzer et al., 2007; De Gloria et al, 2012) in higher education (HE), the deployment rate of SG in HE and their proper insertion in meaningful curricula are still quite low. This is generally attributed to an undefined teacher's reluctance towards the use of games. However, there is also a lack of papers in literature describing deployment of SGs for HE in detail, critically showing their educational benefits and providing guidelines and practices on their use, in comparison with other educational tools/techniques.

With the present paper, we intend to make a first step in the direction of better characterization of the effectiveness and the use of SGs in HE, by reporting our experience in using managerial SGs at different European universities, namely: Genoa (Italy), Bremen (Germany), Nottingham (UK) and Open University of The Netherlands. In particular we describe the deployment of three games, selected because of their quality and ability to cover the course's managerial topics, that are being used in MSc courses in different engineering areas (civil, electronic and industrial). In order to describe and analyse the educational characteristics and effectiveness of each game, we propose the use of models that we have straightforwardly extracted from the major pedagogical paradigms.

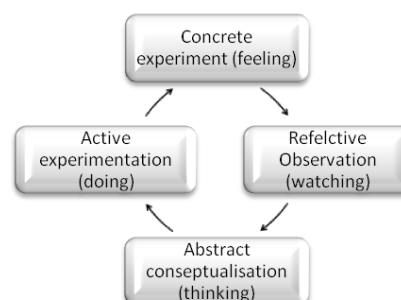
Several pedagogical theories and learning models have been employed to inspire SG design and to assess validity of SGs. Among the knowledge models we highlight the Nonaka SECI model (Nonaka et al., 2000; Nonaka, 1994) is mentioned as a theoretical basis for the use of SG-based workshops, at least in the fields of business, management and manufacturing (Anghern and Maxwell, 2009), and Kirkpatrick's "The Four Levels of Learning Evaluation", which is a popular learning impact assessment

model, involving the following levels: reaction, learning, behaviour, results (Kirkpatrick, 1998). A fifth level of evaluation has been added in new versions of the model by (Phillips, 2007) and by (Watkins et al., 1998), considering also return on investment and impact on clients and society, respectively.

In our work we have focused in particular on describing SGs through two models that we consider complementary, simple and particularly useful to analyse SGs: the Revised Bloom Taxonomy, which is the most popular cognitive approach to SG evaluation (Luccini et al., 2012) (Table 1); and the Kolb's Experiential Learning model (Figure 1), which systemizes the work rooted on Piaget's cognitive developmental genetic epistemology (Piaget, 1929), on Dewey's philosophical pragmatism (Dewey, 1933), and on Lewin's social psychology, putting the experience at the centre of the learning process.

Cognitive competences in the Bloom taxonomy (Bloom, 1956)	Learning goals in the Revised Bloom taxonomy (Anderson and Krathwhol, 2001)
Knowledge	Remembering
Comprehension	Understanding
Application	Applying
Analysis	Analysing
Synthesis	Evaluating
Evaluation	Creating

**Table 1:** Original and revised Bloom taxonomies



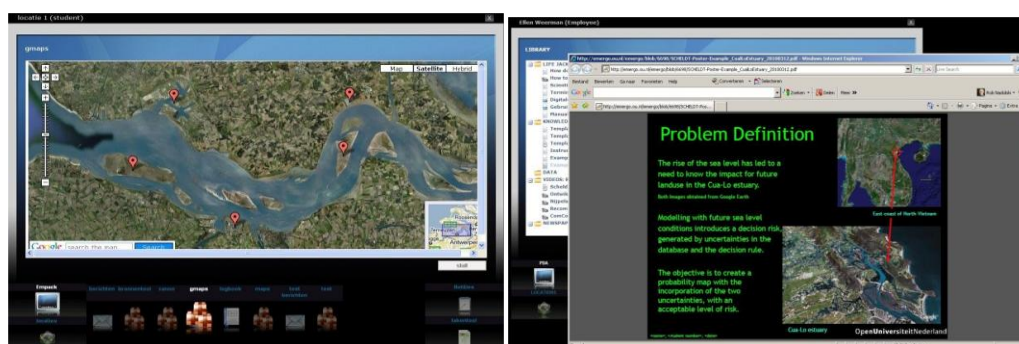
**Figure 1:** Kolb's learning cycle

## 2. Case studies

This section describes three case studies of serious games that the authors deployed in higher education contexts in four countries, namely The Netherlands, Italy, UK and Germany.

### 2.1 Estuarine systems: the Scheldt

The Scheldt is a web-based, role-playing, single-user game developed via the EMERGO methodology and toolkit (Nadolski et al. 2008). EMERGO-games are developed in such a way that the user-interface can be easily replaced without changing game-structure or game-content. Content resources are also separated from the game-structure. This enables easy maintenance and supports sustainability. The learning objective is to analyze, understand and explain the problem of the soil-water systems in the Scheldt (see Figure 2). This concerns a natural science approach towards the threats to our society, and complex spatial and temporal interactions between soil and water.



**Figure 2a):** Googlemaps -tool within the game

**b):** Consulting resources while playing

During gameplay, the student takes the role of a junior researcher-trainee at a virtual company. He receives tasks and feedback from a senior researcher (embedded NPC) during the analysis of increasingly more complex problems and must propose/find workable solutions. He may use web-based tools / GIS sites, multi-various data and models to work towards his solution. This occurs by watching the phenomena and visually inspecting the area (e.g., video, satellite images, GIS sites) in order to solve the question on "Why is land reclamation or loss necessary from a scientific point of view?"

Tasks and feedback are given via company-mail, or via video. Feedback can consist of completed examples and discussion. Students need to compare their own solution these; such as such tasks don't have unequivocal solutions. Then, based on an examples, a consecutive task will be given. In other tasks, feedback is given in a very natural way (for example, reactions from NPC's when consulted during task execution).

The Scheldt (0,7 ECTS) has been embedded in a distance learning course on soil and water (4.3 ECTS) since 2010 at the Open University Netherlands (OUNL). There has been no needed revision of the game. *The Scheldt* is meant for independent self-study, so there are hardly any restrictions concerning the number of enrolled students. However, normally 30-50 students are enrolled every year. The central theme for the game case is "a field study focused on research and exploration of the Scheldt estuary towards relevance for naturalness, accessibility and security." This case concerns a step-wise approach towards the solution of the question "Why is land reclamation or loss necessary from a scientific point of view?" The case is highly realistic and centres on authentic tasks.

### Support for Bloom's cognitive learning goals

Analyzing the EMERGO game, we can see that it supports several learning goals, as reported in the following table.

**Table 2:** Bloom's cognitive learning goals covered by the Scheldt

Learning goal	Modality/mechanics
Remembering	Not explicitly addressed, but is expected during mastery of higher level learning goals.
Understanding	Understanding of the processes associated with the interaction between groundwater and surface water and between soil and water
Applying	To intervene and to propose appropriate measures for the Scheldt estuary towards relevance for naturalness, accessibility and security.
Analysing	The main goal of the game is that students learn to analyze, understand and explain the problem of the soil-water systems in the Scheldt. Analysis subsumes all underlying levels (i.e., remember, understand, apply)
Evaluating	Students need to evaluate and contrast their own solutions with completed examples, need to evaluate their approach towards solving problems, and need to evaluate their learning (i.e., learning to learn).
Creating	Although the problem space is set by the game there is ample room for students to propose alternative solutions considering new, creative points of view.

### Support for Kolb's learning stages

Although Kolb was not explicitly used in the design phase of the game, EMERGO targets thinking and doing, which leads to concrete outcomes and as such conforms to the Kolb cycle.

**Table 3:** Kolb's learning cycle the Scheldt

Learning stage	Modality/mechanics
Concrete experience (feeling)	The student systematically analyzes concrete problems using different tools. The student has the role of a junior researcher-trainee at a virtual company and receives tasks and feedback from a senior researcher (embedded NPC) during the analysis of increasingly more complex problems and proposing/finding workable solutions.
Reflective observation (watching)	As the game play succeeds, the students can observe how their own processes evolve. Based upon this information as well as the indicators delivered by the game, they can observe how they are getting along meeting the overall target of the collaboration as well as that of their own strategy
Abstract conceptualization (thinking)	An NPC provides feedback either via email or videos, and thereby supports conceptualization of new knowledge. Feedback is given via company-mail, or via video, and may consist of worked out examples as well.
Active experimentation (doing)	Based upon the outcome of the previous phase, the player may change the scenario according to the analysis and observation carried out so far.

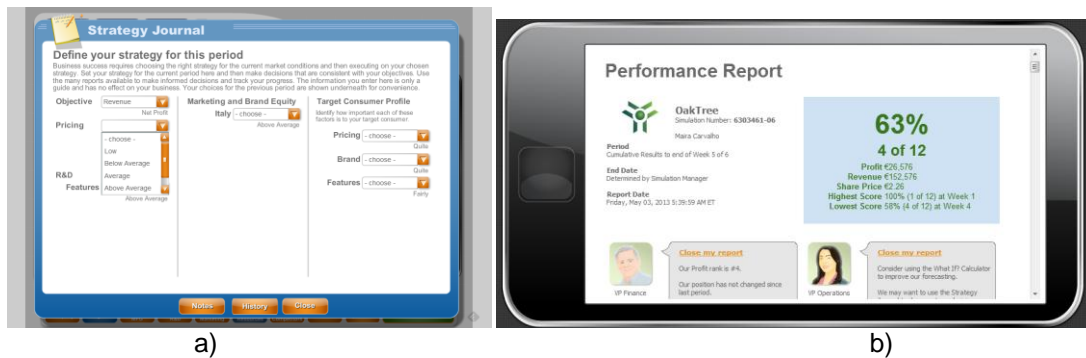
### Support for soft skills

As anticipated, the game supports several soft-skills aspects such as problem solving, strategic thinking, meta-learning.

## 2.2 Any Business: a highly configurable online multiplayer business simulation

*GoVenture Any Business* (<http://goventureanybusiness.com>) is an instructor-customizable business simulation platform that can be used to simulate virtually any type of business, within any industry and any market. It is playable both individually and in teams. The game objective is to successfully manage a business while competing with other companies, managed by other players or by the computer. The Simulation Manager (usually an instructor) has a lot of freedom to configure the simulation, creating scenarios that can range from very simple to very complex/difficult. The Simulation Manager is also able to model specific events or situations to target specific learning goals.

The gameplay consists of making business decisions, which means setting several parameters – price, product features, marketing, human resources, business ethics, among others – before the deadline of each period of the simulation. After the deadline, the simulation advances to the next period and the game presents the results of the previous decisions in terms of sales and profits. A performance score is provided as a weighted sum of different dimensions, and the instructor receives a detailed report with all the activities performed by the students. Every simulation is different (e.g., economic and market conditions), which makes performance not perfectly comparable, but allows for more engaging challenges. Teams compete against each other in the same settings, as in a strategy game, and computer-driven competitors are also generated, creating a good model of the market.



**Figure 3:** The strategy journal, where the player can set and review his strategy's parameters (a), and the Performance report (b)

*GoVenture Any Business* is one of the serious games being used in the second edition of the course on "Entrepreneurship through Serious Games" (eSG) at the University of Genoa, Italy, for the Electronic Engineering M.Sc. degree. The course - which is presently in progress - aims to stimulate entrepreneurship in university students, especially future information technology engineers with little previous academic instruction in economics.

The 3 ECTS course includes a series of lectures/workshops that introduce the theoretical foundations of entrepreneurship, discuss case studies and present the main features of the serious games that are used in the course. The games are played in teams as part of each week assignments, and in addition students are required to fill in questionnaires about the game and the concepts presented in the lectures. By the end of the course, students will have played a total of seven different simulations in *GoVenture Any Business*. The students' actual performance in the games is considered for the final course grade.

### Support for Bloom's cognitive learning goals

Any Business shows a good capability for covering all the levels of the Bloom's taxonomy (Table 4).

**Table 4: Bloom's cognitive learning goals covered by Any Business**

Learning goal	Modality/mechanics
<b>Remembering</b>	The game does not place special emphasis in remembering, as there is contextual help available in the simulation at any time, where the player can revise the main concepts whenever needed. However, practice helps remembering.
<b>Understanding</b>	The game requires the player to understand business concepts, which are important when reading the reports (e.g., company performance reports, market surveys, etc.) available inside the game to make their own successful decisions for the next period.
<b>Applying</b>	Closely related to understanding the business concepts, the player is also required to apply the concepts when making decisions inside the simulation.
<b>Analysing</b>	The concepts of entrepreneurship are used to support the analysis of the results and the data (reports), so that the player is able to make informed decisions in the business, taking into account also the competitors' behavior.
<b>Evaluating</b>	The evaluating learning goal can also be explored by the game, as there is a space for the player to write a decision journal, explaining their business decisions and making also medium-long-term planning (business plan, that can be checked and updated at any simulation period).
<b>Creating</b>	The game, if played in the way intended by the game designers, does not support the creation of new content, as all the decisions must be made within the parameters specified by the simulation manager. However, the possibility of giving students (beside instructors) the possibility of setting up their own simulations (defining markets, industries, etc.) exists, in which case the learning goal of creating original content could be targeted as well.

**Support for Kolb's learning stages**

The authors do not know whether the game was designed on accordance with Kolb's cycle. However, it is quite well supported, as shown in the following table

**Table 5: Kolb's learning cycle Any Business**

Learning stage	Modality/mechanics
<b>Concrete experience (feeling)</b>	In Any Business, the cyclical nature of the game play can be directly mapped to the sequential steps as described by Kolb. Especially in the first period of a simulation, the player needs to set a series of parameters based mostly in his "feeling" of how the decisions will affect the simulation. Even if he does know the business concepts, there is the need to experiment with the many settings in the simulation, which gives a "concrete" experience in the game.
<b>Reflective observation (watching)</b>	As the simulation advances, the player observes the results of the decisions and is able to compare his own performance with the performance of the other companies.
<b>Abstract conceptualization (thinking)</b>	By analysing the several reports provided by the simulation, the player may formulate a mental model of how his decisions affected the results.
<b>Active experimentation (doing)</b>	Finally, using the concepts that were generated by the observation of the results, the player is able to apply the concepts in setting his company's parameters for the next period of the simulation.

**Support for soft skills**

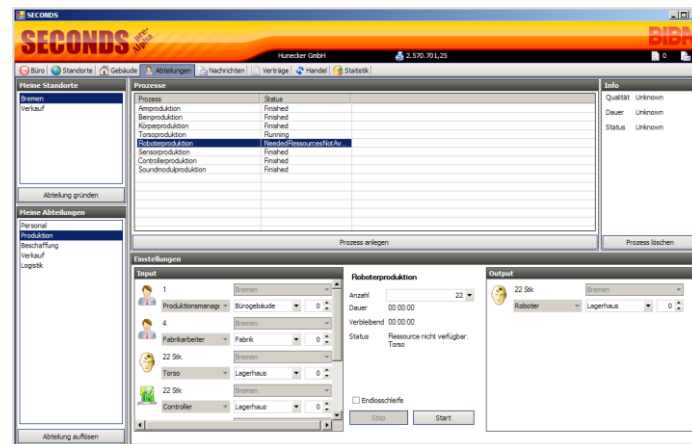
The game supports mainly strategic thinking and decision making. In cases where the game is played in teams, it also supports interpersonal relations, as the decisions made must first be negotiated among all team members, who may also specialize and consider different aspects of company management (e.g., human resources, finance, etc.).

**2.3 Seconds: a role playing game to improve decision making skills**

The game *Seconds*, developed at the University of Bremen, is used to train students in decision making on supply chains (SC) and in distributed production environment. It is a facilitated multi-player, role-based, online game. The game creates a safe learning environment in which the students can apply different approaches for improving the flexibility and efficiency of manufacturing and analyse the impact on the SC. It is configurable, and the level depends on the knowledge level of the player (pre-configured). The goal is adaptable (depending on course setting), but is mostly used to produce a specific product in cooperation, while, taking all costs and expenditures into account. A simplified accounting system is implemented, i.e. the game delivers several performance indicators that are used for the analysis and calculation. The gaming scenario evolves as the players play the game. Depending on production volume and time, the player can gain experience and skills needed for



producing higher quality. Target users are master students from industrial, production and system engineering and MSc logistics and operational management.



**Figure 4:** GUI shows the input needed for producing robots, as well as all processes at the site in Bremen, dept. of production

The game is used at the **University of Bremen** as part of a 3 ECTS lab course on “Decision making in distributed production environment”, which uses a blended learning concept. This part is comprised of 6 units- one for introduction to the basics of SCM and a tutorial on the gaming environment and five for playing. Methods for strategic decision making are successively introduced into the course. Each session lasts 5 hours. On average, the play time is 3-3,5 hours for each session and at least 30-45' for debriefing and reflection.

For two years, *Seconds* has also been used at the **University of Nottingham**. There, it is used as a supplement to a post graduate course on Supply Chain management. Therefore, there is no introduction to strategic decision making in supply chain or in the basics of SCM, since this is knowledge already known to the students, i.e. the students come solely to play the game. So far, the students had have played twice. The sessions have taken around 2,5 hours with an additional 30 minutes for debriefing. In this case, the students received predefined scenarios with all company processes already implemented; i.e. the degree of freedom for taking decision on production sites etc. was lower than in the German case

### Support for Bloom's cognitive learning goals

Actually, in the design phase of *Seconds*, Blooms taxonomy was hardly considered. Consequently only the higher levels are supported. This is typical for this type of game; it emphasizes on the two highest levels of evaluating and creating.

**Table 6:** Bloom's cognitive learning goals covered by *Seconds*

Learning goal	Modality/mechanics
Remembering	The simulation model in <i>Seconds</i> hardly supports remembering. It is actually expected that the students have the knowledge beforehand, in order to focus more on the application of the knowledge. The player needs to recall this pre-requisite knowledge without any support from the game, except to some extent information gathering, since the different GUI helps the players find the right information source.
Understanding	Understanding is only partially supported by <i>Seconds</i> . The system delivers the information. It supports the player to understand the decision process as well as to understand how the supply chain and the production plan work. However, it must be stated that this process is only partly supported by the system. Far more important is the role of the facilitation process in the debriefing phases. This phase is outside the game, but essential for the success of the game play and for reaching the learning goals.
Applying	<i>Seconds</i> is designed to support the users in applying their strategic SCM and to make their decisions accordingly. The players can apply strategic decision making methods, change the operational processes or modify the scenario
Analysing	With the information delivered by the system the player is able to analyse and compare his results to the played strategy and whether they are compliant to SCM theories. He can compare the result with others and identify risks and opportunities.
Evaluating	The game delivers enough information to evaluate the learning outcome, but this is normally actually carried out in the debriefing session as well as in the analysis carried out by the students after each class.
Creating	The game supports creation of new content, because it helps the player to identify specific structures and pattern. It encourages the players to combine different information and to construct new knowledge based on these experiences. This is possible due to a high degree of freedom in the gaming environment and few boundaries.

### Support for Kolb's learning cycle

The use of Seconds uses an extension of Kolb's learning cycle: it uses the BIG (beyond the information given) defined by Perkins (1991, p. 20) BIG constructivism. Following the BIG approach, a facilitator directly introduces the concepts, provides examples to the students with concrete experience in activities that challenge them to apply, generalise and refine their initial understanding in multiple activities. This approach presents information to the learners but stresses the need to go beyond the information given.

**Table 7:** Support of Kolb's learning cycle due to the BIG approach

Learning stage	Modality/mechanics
Concrete experience (feeling)	The concept for Seconds foresees the use of BIG constructivism, so the students receive a starting scenario and a role for which they must choose a strategy to follow throughout the game play. At the beginning, the students do not have enough information to make their decisions based upon what is happening in the game, but rather of what they think may happen. For every time the students change the strategy (normally after the debriefing phase), they will again make their feeling-based decision based, but as the game proceeds, these are more and more related to what has happened in the game in the past, so that only radical changes are still made purely on the students perception.
Reflective observation (watching)	As the game play succeed, the student can observe both how their own processes evolves depending on his/her own decisions but also how the decisions affect the collaboration with the other players. Based upon this information as well as the indicators delivered by the game; he can observe how close the overall target of the collaboration is being met, as well as that of his own strategy.
Abstract conceptualization (thinking)	In Seconds this is supported in two ways- during game play, the student can draw his conclusion based on how his indicators (financial, stock level, use of material, material flow etc.) emerge. The players are encouraged to use the left hand elicitation method during the game for this process in combination with the introduced methods for strategic decision making; however, this is a challenge for several students, so that they often do only apply the methods. This process is strongly supported in the common debriefing session and by the facilitation of the game.
Active experimentation (doing)	Based upon the outcome of the previous phase, the player changes the scenario according to the analysis and observation carried out so far.

### 3. Lessons learned and good practices

Quantitative results from the deployment of the games are not yet available from each game. However, the experience gained from the field allows us to make some considerations that we believe could be useful for educators.

In general, in order to guarantee successful deployment it is important to carefully align gaming goals with course goals and course assessment (i.e., constructive alignment). Deploying a new game is a complex and time-consuming activity that ideally requires the development of an ad-hoc deployment plan, specifying goals (educational and in-game) and context of use. Also student feedback should be carefully considered, in order to tune the game in terms of contents, difficulty levels, pace, etc. Fine-tuning the parameters for the games and deciding how much playing will be employed in a course can be a challenge. It is difficult to organize a sequence of game matches/sessions that continuously engage the students, while representing a proper educational path usable during a whole course, or part of it. Also, the number and duration of the sessions is relevant to the manner of interaction between students, especially regarding collaboration. For example, in the game Seconds, it was observed that the students' willingness to make compromises/trade-offs and to make strategic collaborations is higher, on average, in the groups having five sessions than those having two (thus showing a collaboration learning effect).

For competitive games, the teacher should thus support the weaker teams, in order to enhance the overall competitiveness, whereas for a collaborative game setting, it is more important that the game environment is able to support different competence levels within the same gaming scenario. In facilitated games, the facilitator's role is essential.

Documentation should be easily accessible online, in particular during the game and also the game developer support should be available, at least in the phases of course design and early deployment.

While the term SG is appealing, in particular for students, state of the art SGs have generally limited entertainment features, especially if compared with the best selling videogames. Tools like AnyBusiness are frequently referred to as a business simulations, without specific serious games mechanics (i.e., able to join fun and instruction). However, inter-team competition even through the



simple mechanics of score and other performance indicators (e.g., cashflow, profit and loss, etc.) are an excellent motivator.

SGs for complex scenarios should typically be used in blended learning settings, with briefing and debriefing sessions in order to complement and reflect on the experience, possibly also with questionnaires. Games designed to be facilitated should not be played in single mode or without facilitator, since intra-team relationships are very useful and the overview of an expert is very important both for the contents and for the game procedures themselves.

In addition to the time factor of each game session, another critical factor concerns the instructions given to the students before and during the game (both concerning the contents and the game itself). It is possible to allow the students to freely manage their roles. However – this is a common rule in education - freedom should be limited for students having less knowledge about the target domain, in order to make the learning process more efficient and to help them overcome hurdles, concerning both the playability and the contents. Moreover, in-game knowledge (typically procedural and intuitive) should be complemented with other type of information, typically verbal and objective.

The facilitator or the teacher should pay attention at the students' learning outcomes after (and possibly also during) the game, in order to detect misconceptions, that are likely to appear, according to our experience, given the students' procedural and empirical approach.

A crucial step when preparing a course exploiting SGs is the actual choice of the games. The first step involves the collection of requirements related to the course and the curriculum. Addressed items include: target group, credits, learning objectives, which skills and competences should be trained, connection to the overall curriculum, underlying technical infrastructure, course setting, embedding with other learning material, use of blended learning concepts or not, number and length of units, feedback and assessment needs, pre-requisites (compare Nadolski, 2008).

The candidate games' features will need to be analysed in the light of the above mentioned requirements. Typical criteria for selection include various factors, such as: coverage of the needed educational topics; matching between the course's learning objectives and the game's features; costs (both in terms of software and of deployment and of maintenance); usability; quality of user assessment and provision of feedback (Bellotti et al., 2013); game adaptability; knowledge transferability; in house competencies and time availability in case development of a new serious game was considered; degree of freedom for players and teachers; support to collaboration; SG's learning curve, difficulty level and long-term playability; competences and effort needed on the teacher's side; availability of additional educational material related to the game. A main challenge in the selection process is the difficulty in having a critical and complete overview of existing games.

Depending on the weight of each one of the above criteria, existing games can be matched, and a "make or buy" decision may also be done. In the second case some of the collected requirements may need to be adapted. In the case studies presented in this paper, different needs led to different choices. In the first case (the Scheldt), the game had perfectly to comply with distance education and should partly serve as a replacement of fieldwork. Consequently, an ad-hoc development was deemed as necessary. The second case study (Any Business), a comparative analysis of several state of the art games was carried out, based on the main criteria of entrepreneurship topic coverage and per-license costs lower than €30. For the third case study (Seconds), a review was performed of the few available games on supply chain management and of several simulation environments as well. Since simulations were considered very good for mapping the real world processes, excessively difficult for the students, and the games not complex enough, in-house development was decided, allowing also the implementation of collaborative features, mirroring the work carried out in the production network.

#### **4. Conclusions and Future Work**

All the three studied games typically focus on the higher levels of the revised Bloom's taxonomy (analysing, evaluating and creating), in different ways and to different extents. The Scheldt emphasises the analysing level, whereas Any Business the evaluating level. Seconds focuses on supporting students to learn to create new knowledge. These differences substantially reflect the targets of the games and the corresponding courses.

Our observations (though still qualitative) highlight that this has a strong relationship with the role of the teacher/instructor/facilitator. The higher level to be achieved according to Bloom, the more emphasis has to be put on supporting the abstraction process, which typically requires the teacher's intervention. This process is only partly supported in the three games and related documentation, so it is very important that the teacher designs a proper pedagogical plan to make the game experience profitable from a real learning point of view. Also during the lectures, the presence of a teacher is very important, introducing and explaining topics and giving indications and discussing the experience with students. In Seconds, furthermore, the gameplay itself is accompanied by a teacher, while Any Business has been played at home by the competing teams and feedback has been provided by the teachers during the debriefing discussion. In The Scheldt, in-game feedback is provided by an NPC player, which aims at nurturing the thinking process, even if with a lower quality than through a human teacher. This game is made for an online university course, and thus it is also only offered in single user mode.

We do not agree that new education practices should turn the teacher from a "teaching machine" into a consultant nor a simple facilitator. We believe that SGs are powerful and complex tools that need the adult expertise and competences. Overall, the adult's presence is necessary for the educational role of leading students to knowledge and understanding of/access to reality. A proper use of SGs, instead of limiting the teacher's role, requires even better prepared teachers, and able to introduce students to aspects of reality by using a potentially powerful simulation tool. In the Any Business course, lectures involved the presence of three other researchers for supporting the official teacher by monitoring the teams' behaviours during the de-briefing (probably one would have been enough, but we preferred two given the experimental case).

Our analysis has shown that all the three games seem to correspond to the Kolb's learning model, even though the model had not been explicitly taken into consideration at the design level. Whereas The Scheldt emphasises concrete experience and reflective observation, the other two games, at least in the multi-player settings with debriefing, seem to be more focused on an abstract conceptualisation.

Regarding the effectiveness of the games, it can be reported that the students who had used The Scheldt received high grades on the final exam that was conducted after completing the game (average score 8.9 (maximum 10)). For Any Business, the preliminary results after four game sessions of one week each show that the game supports strategic thinking and requires and stimulates a deep understanding of the simulation environment. It can also be seen that the different reports generated by the game help in analysing and taking decision. Moreover, competition is really compelling for the majority of the players. The market conditions are determined by the abilities of the competing teams. Seconds has been used for decision making for more than 6 years. The available results mainly show that the game helps the students in applying methods and constructing new knowledge, and support strategically thinking.

Our experience in deploying the targeted games indicates some important reasons for the current low penetration rate of GBL in HE. The game that seems to be most easily to integrate is The Scheldt, for which only few adjustments were necessary. For the other courses that involved the presence of one or more teachers, it can be concluded that it is difficult to set up a course integrating the use of a SG, since the playing time, the length and plan of the sessions, the modalities for keeping the motivation etc. are difficult to estimate in advance. Thus, these courses often have to undergo an iterative design process, adapting the course set-up depending on the evaluation of the learning outcomes. This requires a continuously monitoring and a proper working experience. Taken into account the cost of this work, the experimental design, and the low number of students in each class it is still a question if the resources used for implementing GBL are efficiently used.

Despite the consensus on their potential (in particular due to the technological/graphic appeal, interactivity and the huge data processing/storing capabilities), the deployment rate of SG in HE is still quite low. We argue that this is due to the fact that games are more naturally suited to children than to adults. Moreover, educational effectiveness of games is easier to achieve with simpler content, while more complex and costly games are necessary in order to efficiently and effectively achieve the needed educational targets. Finally, integration in existing curricula is not straightforward and requires a careful pedagogical planning and a smart usage of games. So, we think that a lot of work is still to be done, in particular to understand how to use it and how to design its insertion in the course so that it is really effective for students.

## Acknowledgment

This work was partially funded by the European Union, under the Framework Programme 7 (Information Society Technologies - ICT), in the Games and Learning Alliance (GaLA) Network of Excellence, Grant Agreement nr. 258169.

This work was supported in part by the Erasmus Mundus Joint Doctorate in Interactive and Cognitive Environments, which is funded by the EACEA Agency of the European Commission under EMJD ICE FPA n 2010-0012

## References

- Anderson, L W., Krathwohl, D. R. Eds. (2001) *A Taxonomy for Learning, Teaching and Assessment: A Revision of Bloom's Taxonomy of Educational Objectives*. New York: Longman.
- Anghern, Albert A. and Maxwell, Katrina (2009) *EagleRacing: Addressing Corporate Collaboration Challenges Through an Online Simulation Game*, Innovate, Journal of Online Education, Vol. 5, Iss. 6.
- Baalsrud Hauge, J., Delhoum, S., Scholz-Reiter, B., Thoben, Klaus-Dieter (2007) *The Evaluation of Learning the Task of Inventory Control with a Learning Lab*. In: *Learning with Games*., Sofia Antipolis, France. pp. 1-8.
- Bellotti F., Berta R. and De Gloria A. (2010) *Designing Effective Serious Games: Opportunities and Challenges for Research*, Special Issue: Creative Learning with Serious Games, Int.l Journal of Emerging Technologies in Learning (IJET), Vol. 5, pp. 22-35
- Bellotti F., R. Berta, De Gloria A., D'Ursi A., and Fiore V. (2012). A serious game model for cultural heritage. ACM J. Comput. Cult. Herit. 5, 4.
- Bellotti F., Kapralos B., Lee K., Moreno-Ger P., and Berta R. (2013), "Assessment in and of Serious Games: An Overview", Hindawi Advances in Human-Computer Interaction
- Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R.(1956). *Taxonomy of educational objectives: the classification of educational goals*, Handbook I: Cognitive Domain New York, Longmans, Green.
- De Gloria, A. Bellotti, F., Berta,R (2012) *Building a Comprehensive R&D Community on Serious Games*, 4<sup>th</sup> Int.l Conference on Games and Virtual Worlds for Serious Applications, VS-Games 2012, Genova.
- Dewey, J. (1933) *"How We Think"*, New York: Heath.
- Greitzer F.L., Kuchar O.A., and Huston K. (2007), *Cognitive Science Implications for Enhancing Training Effectiveness in a Serious Gaming Context*, ACM J. Educational Resources in Computing, vol. 7, no. 3
- Kirkpatrick, D. L. (1998) "Evaluating Training Programs: The Four Levels". 2nd Edition, Berrett-Koehler Publishers, Inc, San Francisco.
- Kolb, D. A. (1984) *Experiential Learning*, Englewood Cliffs, NJ.: Prentice Hall, pp. 20-38, retrieved at <http://academic.regis.edu/ed205/Kolb.pdf> on 30 September 2012
- Luccini, M, A. M. Luccini, M. Mortara, C. E. Catalano, M. Romero (2012) Thematic Application fields report, deliverable 3.2 of the Games and Learning (GaLA) Network of Excellence.
- M Mantakas, (2010) *Using a management game within an entrepreneurship training project for the students of an informatics and telecommunications degree*, Proceedings of the SGEED-2010 Conference Serious Games, Education & Economic Development [http://www.serious-gaming.info/@api/deki/files/144/=12\\_Mantakas\\_business\\_game.pdf](http://www.serious-gaming.info/@api/deki/files/144/=12_Mantakas_business_game.pdf)
- Nadolski, R. J., Hummel, H. G. K., Van den Brink, H. J, Hoefakker, R., Sloodmaker, A., Kurvers, H., & Storm,J. (2008) *EMERGO: methodology and toolkit for efficient development of serious games in higher education*, Simulations & Gaming, 39(3), pp. 338-352.
- Nonaka, I., Toyama, R. and Konno, N. (2000). "SECI, Ba, and leadership: a unified model of dynamic knowledge creation". Long Range Planning, 33, 5- 34.
- Perkins, D. N.: Technology meets constructivism: Do they make a marriage?, in
- Phillips, J. J. (2007). "Measuring ROI – Fact, Fad, or Fantasy". ASTD White Paper, retrieved at <http://www.ddiworld.com/DDIWorld/media/articles/Best-of-TD-Measuring-and-Evaluating-Learning.pdf>
- Piaget, J. (1929) "The Child's Conception of the World". NY: Harcourt, Brace Jovanovich
- Riedel, J. and K. Pawar (2009) *A Report On The Experiences Gained From Evaluating The Cosiga NPD Simulation Game*, IPDMC09, International Product Development Management Conference, 7-8, Twente, The Netherlands, CD-Rom, EIASM, Brussels
- Watkins, R., Leigh, D., Foshay, R. and Kaufman, R. (1998). *Kirkpatrick Plus: Evaluation and Continuous Improvement with a Community Focus*, Educational Technology Research & Development, 46(4): 90-96